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(54) OVERTURN PREVENTION METHOD AND DEVICE FOR TWO-WHEEL VEHICLE

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(56) References cited:
DE-A1- 3 839 520
DE-A1-102008 001 970
DE-A1-102009 046 226
DE-A1-102009 054 756
DE-A1-102010 003 951
JP-A- H0 316 889
JP-A- 2004 099 026
JP-A- 2004 155 412

- **"Kurvenfahrt mit Gas?", MOTORRD online24 , 20 April 2009 (2009-04-20), page 5PP, XP002758785, Retrieved from the Internet: URL:http://www.motorradonline24.de/mo24forum/bike-und-biker/biker-stammtisch/622770/kurvenfahrt-mit-gas/ [retrieved on 2016-06-15]**

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EP 2 886 431 B1

Description

Technical Field

[0001] The present invention relates to a two-wheeled vehicle and particularly relates to a two-wheeled motor vehicle overturn prevention method and device.

Background Art

[0002] In order to improve the traveling stability of a two-wheeled vehicle particularly when traveling around a curve, a two-wheeled motor vehicle engine torque adjustment method such as described in JP-A-2004-99026, for example, is known. In this device, a maximum value of the acceleration force or the acceleration in the traveling direction is found as a function of the centrifugal force or lateral acceleration acting on the vehicle body during travel around a curve, and the engine torque is controlled so as to not exceed the maximum value that has been found. That is, the two-wheeled vehicle is kept from accelerating so as to prevent sideways skidding of the vehicle wheels when traveling around a curve. This is because too much acceleration or braking of the two-wheeled vehicle during travel around a curve at a high velocity will cause the tires to skid sideways.

Citation List

Patent Literature

[0003]

PTL 1: JP-A-2004-99026
PTL 2: DE 38 39 520 A

Non-Patent Literature

[0004] NPTL 1: "Kurvenfahrt mit Gas?", (20090420), page 5PP, MOTORRD online24, URL: http://www.motorradonline24.de/mo24forum/bike-und-biker/b iker-stammtisch/622770/kurvenfahrt-mit-gas/, (20160615), XP002758785 [Y] 9 * page 1, comment from "Voidhawk" page 2, comment from "mille" * [A] 1,3.

[0005] PTL 2 discloses a motorcycle as in Figure 1 here, explaining a stable, inclined position. The lean angle will depend on vehicle speed and curve radius. The general approach in this art is to consider one maximum lean angle which is usually defined by the geometry of the vehicle and tire grip. PTL 2 also discloses the relevant equations for this.

[0006] NPL 1 explains, in particular in the comment from "mille", clearly that adding "GAS", i.e. drive force, reduces lean angle, whereas reducing drive force increases the lean angle and may cause the motorcycle to fall to the inner side of a curve.

Summary of Invention

Technical Problem

[0007] However, in the above-described conventional art, no consideration is given to traveling instability of the two-wheeled vehicle in the low-velocity region. When a rider drives a two-wheeled motor vehicle, oftentimes the two-wheeled motor vehicle loses balance and overturns in the low-velocity region, and when the rider makes a right turn at a low velocity with the handlebar turned, particularly such as when making a U-turn, there are cases where the right hand of the rider comes into contact with the fuel tank and cannot open the accelerator, so that the two-wheeled motor vehicle loses velocity and overturns. Compared to the high-velocity region, in the low-velocity region, even small changes in velocity greatly affect the traveling stability of the vehicle body.

[0008] In light of this, it is an object of the present invention to ensure the traveling stability of a two-wheeled vehicle particularly in the low-velocity region. In particular, it is the object of the invention to provide a two-wheel vehicle overturn prevention method and a two-wheel vehicle overturn prevention device which can ensure stability of a two-wheel vehicle in a low velocity region.

Solution to the Problem

[0009] This object is solved by method according to claim 1 and claim 3 and by a device according to claim 9 and claim 10. Further advantageous embodiments and improvements of the invention are listed in the dependent claims. Hereinafter, the invention will be described with reference to its advantageous embodiments and the attached drawings. Below, however, first some important aspect of the invention are listed.

[0010] According to the one aspect of the invention, there is provided a two-wheeled vehicle overturn prevention method, wherein maximum allowable lean angles corresponding to vehicle body velocities are preset in relation to lean angles of a vehicle body, an estimated lean angle, which is a lean angle of the vehicle body after a predetermined amount of time, is estimated on the basis of a temporal change in an actual lean angle of the vehicle body, an estimated vehicle body velocity, which is a vehicle body velocity of the vehicle body after the predetermined amount of time, is estimated on the basis of a temporal change in an actual vehicle body velocity of the vehicle body, and in a case where the estimated lean angle exceeds or looks to exceed a maximum allowable lean angle corresponding to the estimated vehicle body velocity, the two-wheeled vehicle overturn prevention method is adapted to accelerate the vehicle body or keep the vehicle body from decelerating. According to this configuration, maximum allowable lean angles corresponding to vehicle body velocities are preset in relation to lean angles of a vehicle body, an estimated lean angle, which is a lean angle of the vehicle body after a

predetermined amount of time, is estimated on the basis of a temporal change in an actual lean angle of the vehicle body, an estimated vehicle body velocity, which is a vehicle body velocity of the vehicle body after the predetermined amount of time, is estimated on the basis of a temporal change in an actual vehicle body velocity of the vehicle body, and in a case where the estimated lean angle exceeds or looks to exceed a maximum allowable lean angle corresponding to the estimated vehicle body velocity, the two-wheeled vehicle overturn prevention method is adapted to accelerate the vehicle body or keep the vehicle body from decelerating, so the two-wheeled vehicle can be prevented from overturning without changing the will of the driver relating to the turning radius particularly when traveling around a curve at a low speed at which it is easy for the two-wheeled vehicle to lose balance, such as a U-turn. Furthermore, the traveling state after the predetermined amount of time is estimated and control is performed, so the drive force of the engine can be changed to accelerate the vehicle body at an appropriate timing or the vehicle body can be kept from decelerating.

[0011] According to the another aspect of the invention, there is provided the two-wheeled vehicle overturn prevention method according to claim 1, wherein in a case where the estimated lean angle exceeds a maximum allowable lean angle corresponding to the estimated vehicle body velocity, an engine drive addition quantity is calculated so as to minimize the difference between a vehicle body velocity corresponding to the estimated lean angle serving as a maximum allowable lean angle and the estimated vehicle body velocity.

[0012] According to the still another aspect of the invention, there is provided a two-wheeled vehicle overturn prevention method, wherein maximum allowable lean angles corresponding to vehicle body velocities are preset in relation to lean angles of a vehicle body, and in a case where an actual lean angle of the vehicle body exceeds a maximum allowable lean angle corresponding to an actual vehicle body velocity of the vehicle body, the two-wheeled vehicle overturn prevention method is adapted to accelerate the vehicle body. According to this configuration, maximum allowable lean angles corresponding to vehicle body velocities are preset in relation to lean angles of a vehicle body, and in a case where an actual lean angle of the vehicle body exceeds a maximum allowable lean angle corresponding to an actual vehicle body velocity of the vehicle body, the two-wheeled vehicle overturn prevention method is adapted to accelerate the vehicle body, so the two-wheeled vehicle can be prevented from overturning without changing the will of the driver relating to the turning radius particularly when traveling around a curve at a low speed at which it is easy for the two-wheeled vehicle to lose balance, such as a U-turn.

[0013] According to yet another aspect of the invention, there is provided the two-wheeled vehicle overturn prevention method according to claim 3, wherein in a case where an actual lean angle of the vehicle body exceeds a maximum allowable lean angle corresponding to an actual vehicle body velocity of the vehicle body, an engine drive addition quantity is calculated so as to minimize the difference between a vehicle body velocity corresponding to the actual lean angle serving as a maximum allowable lean angle and the actual vehicle body velocity.

[0014] According to another aspect of the invention, there is provided the two-wheeled vehicle overturn prevention method according to claim 2 or 4, wherein the drive addition quantity is calculated by PID control.

[0015] According to another aspect of the invention, there is provided the two-wheeled vehicle overturn prevention method as explained above, wherein a maximum value of the drive addition quantity is preset, and in a case where the drive addition quantity that has been calculated has maintained the maximum value over a predetermined amount of time, the drive addition quantity is changed to zero. According to this configuration, a maximum value of the drive addition quantity is preset, and in a case where the drive addition quantity that has been calculated has maintained the maximum value over a predetermined amount of time, the drive addition quantity is changed to zero, so the two-wheeled vehicle can be prevented from being accelerated more than necessary in a case where an error has occurred in the lean angle detection value or the vehicle velocity correction amount.

[0016] According to another aspect of the invention, there is provided the two-wheeled vehicle overturn prevention method as explained above, wherein the method is executed only in a predetermined vehicle body velocity region. According to this configuration, the method is executed only in a predetermined vehicle body velocity region, so the two-wheeled vehicle can be prevented from being further accelerated when traveling at a high speed.

[0017] According to another aspect of the invention, there is provided the two-wheeled vehicle overturn prevention method as stated above, wherein an actual lean angle of the vehicle body is calculated on the basis of an output value of a lean angle sensor, and the lean angle sensor is at least one of a lateral acceleration sensor, a vertical acceleration sensor, a yaw rate sensor, and a roll rate sensor.

[0018] According to another aspect of the invention, there is provided a two-wheeled vehicle overturn prevention device comprising: a vehicle velocity sensor that detects a vehicle body velocity; a lean angle sensor for detecting a lean angle of a vehicle body; lean angle calculating means that calculates a lean angle of the vehicle body on the basis of an output value of the lean angle sensor; instability judging means that judges traveling instability of the vehicle body on the basis of the vehicle body velocity and the lean angle; drive addition quantity calculating means that calculates an engine drive addition quantity in a case where it has been judged by the instability judging means that the vehicle body is unstable; and drive force increase instructing means that outputs a drive addition quantity to an engine ECU. Accord-

ing to this configuration, the two-wheeled vehicle overturn prevention device is equipped with instability judging means that judges traveling instability of the vehicle body on the basis of the vehicle body velocity and the lean angle and drive addition quantity calculating means that calculates an engine drive addition quantity in a case where it has been judged by the instability judging means that the vehicle body is unstable, so the two-wheeled vehicle can be prevented from overturning without changing the will of the driver relating to the turning radius particularly when traveling around a curve at a low speed at which it is easy for the two-wheeled vehicle to lose balance, such as a U-turn.

[0019] According to another aspect of the invention, there is provided the two-wheeled vehicle overturn prevention device according to claim 9, further comprising vehicle body velocity storing means that stores an output value of the vehicle velocity sensor, lean angle storing means that stores an output value of the lean angle calculating means, vehicle body velocity estimating means that calculates an estimated vehicle body velocity, which is a vehicle body velocity of the vehicle body after a predetermined amount of time, on the basis of a temporal change in an output value of the vehicle velocity sensor, and lean angle estimating means that calculates an estimated lean angle, which is a lean angle of the vehicle body after a predetermined amount of time, on the basis of a temporal change in an output value of the lean angle calculating means, wherein the instability judging means judges traveling instability of the vehicle body on the basis of the estimated vehicle body velocity and the estimated lean angle. According to this configuration, the two-wheeled vehicle overturn prevention device is equipped with vehicle body velocity storing means that stores an output value of the vehicle velocity sensor, lean angle storing means that stores an output value of the lean angle calculating means, vehicle body velocity estimating means that calculates an estimated vehicle body velocity, which is a vehicle body velocity of the vehicle body after a predetermined amount of time, on the basis of a temporal change in an output value of the vehicle velocity sensor, and lean angle estimating means that calculates an estimated lean angle, which is a lean angle of the vehicle body after a predetermined amount of time, on the basis of a temporal change in an output value of the lean angle calculating means, wherein the instability judging means judges traveling instability of the vehicle body on the basis of the estimated vehicle body velocity and the estimated lean angle, so the two-wheeled vehicle can be prevented from overturning without changing the will of the driver relating to the turning radius particularly when traveling around a curve at a low speed at which it is easy for the two-wheeled vehicle to lose balance, such as a U-turn. Furthermore, the traveling state after the predetermined amount of time is estimated and control is performed, so the drive force of the engine can be changed to accelerate the vehicle body at an appropriate timing or the vehicle body can be kept from decelerating.

[0020] According to still another aspect of the invention, there is provided the two-wheeled vehicle overturn prevention device according to claim 9, wherein maximum allowable lean angles corresponding to vehicle body velocities are preset in relation to lean angles of a vehicle body, and the instability judging means judges traveling instability of the vehicle body on the basis of the vehicle body velocity, the lean angle that has been calculated, and the maximum allowable lean angle.

[0021] According to another aspect of the invention, there is provided the two-wheeled vehicle overturn prevention device as explained above, wherein the drive addition quantity calculating means calculates an engine drive addition quantity so as to minimize the difference between a vehicle body velocity corresponding to the calculated lean angle serving as a maximum allowable lean angle and the vehicle body velocity that has been detected.

[0022] According to another aspect of the invention as explained above, there is provided the two-wheeled vehicle overturn prevention device as explained above, wherein maximum allowable lean angles corresponding to vehicle body velocities are preset in relation to lean angles of a vehicle body, and the instability judging means judges traveling instability of the vehicle body on the basis of the estimated vehicle body velocity, the estimated lean angle, and the maximum allowable lean angle.

[0023] According to another aspect of the invention, there is provided the two-wheeled vehicle overturn prevention device as explained above, wherein the drive addition quantity calculating means calculates an engine drive addition quantity so as to minimize the difference between a vehicle body velocity corresponding to the estimated lean angle serving as a maximum allowable lean angle and the estimated vehicle body velocity.

[0024] According to another aspect of the invention, there is provided the two-wheeled vehicle overturn prevention device as explained above, wherein the drive addition quantity calculating means calculates a drive addition quantity by PID control.

[0025] According to another aspect of the invention, there is provided the two-wheeled vehicle overturn prevention device as explained above, wherein a maximum value of the drive addition quantity is preset, and the two-wheeled vehicle overturn prevention device further comprises drive force increase limiting means which, in a case where the drive addition quantity that has been calculated has maintained the maximum value over a predetermined amount of time, changes the drive addition quantity to zero. According to this configuration, a maximum value of the drive addition quantity is preset, and the two-wheeled vehicle overturn prevention device further comprises drive force increase limiting means which, in a case where the drive addition quantity that has been calculated has maintained the maximum value over a predetermined amount of time, changes the drive addition quantity to zero, so the two-wheeled vehicle can be

prevented from being accelerated more than necessary in a case where an error has occurred in the lean angle detection value or the vehicle velocity correction amount.

[0026] According to another aspect of the invention, there is provided the two-wheeled vehicle overturn prevention device as explained above, wherein the two-wheeled vehicle overturn prevention device acts only in a predetermined vehicle body velocity region. According to this configuration, the two-wheeled vehicle overturn prevention device acts only in a predetermined vehicle body velocity region, so the two-wheeled vehicle can be prevented from being further accelerated when traveling at a high speed.

[0027] According to another aspect of the invention, there is provided the two-wheeled vehicle overturn prevention device as explained above, wherein the lean angle sensor is at least one of a lateral acceleration sensor, a vertical acceleration sensor, a yaw rate sensor, and a roll rate sensor.

Advantageous Effects of Invention

[0028] According to the present invention, the traveling stability of a two-wheeled vehicle particularly in the low-velocity region can be ensured.

Brief Description of Drawings

[0029]

[FIG. 1] FIG. 1 is a drawing schematically showing forces acting on a leaning two-wheeled vehicle.
[FIG. 2A] FIG. 2A is a system configuration diagram including the device of the present invention.
[FIG. 2B] FIG. 2B is a system configuration diagram including another embodiment of the device of the present invention.
[FIG. 3A] FIG. 3A is a flowchart showing processing in the method of the present invention.
[FIG. 3B] FIG. 3B is a flowchart showing processing in another embodiment of the method of the present invention.
[FIG. 4] FIG. 4 is a drawing showing an example of a map used in the processing of FIG. 3A or FIG. 3B.
[FIG. 5] FIG. 5 is a drawing showing an example of the action of drive force increase limiting means. Description of Embodiments

[0030] Embodiments of the present invention will be described below with reference to the attached drawings.

[0031] First, the principle of the method of the present invention will be described. A load in the direction of gravity and an outward centrifugal force act on a leaning two-wheeled vehicle. When these force are schematically represented using Y-Z coordinates, they appear as shown in FIG. 1. FIG. 1 is a front view (or a back view) of a two-wheeled vehicle and a driver when making a right turn, and the two-wheeled vehicle has an inwardly leaning posture in relation to the turning radius direction. In FIG. 1, 100 denotes the vehicle wheels of the two-wheeled vehicle and 101 denotes the upper structure of the two-wheeled vehicle including the driver. 102 denotes the head of the driver. θ is the lean angle (the angle of inclination relative to the direction of gravity) of the two-wheeled vehicle. The load and the centrifugal force are denoted by vectors F1 and F2, respectively, taking a center of gravity G of the two-wheeled vehicle including the driver as an initial point. As shown in FIG. 1, when Y'-Z' coordinates taking the center of gravity G as an origin are defined, it will be understood that in order to maintain the lean angle θ at a constant, it is necessary for the Y' component F1y' of the load F1 and the Y' component F2y' of the centrifugal force F2 to be in balance. At this time:

$$|F1y'| = |F2y'|$$

[0032] In the case of $|F1y'| > |F2y'|$, the lean angle θ is large and the vehicle body moves in the direction in which it falls over. On the other hand, in the case of $|F1y'| < |F2y'|$, the lean angle θ is small and the vehicle body moves in the direction in which it is righted.

[0033] Here, assuming that m represents the load, which is to say the combined load of the two-wheeled vehicle and the driver, r represents the turning radius when traveling around a curve, and v represents the vehicle body velocity of the two-wheeled vehicle, the centrifugal force $F2 = mv^2/r$ and consequently $F2y' = mv^2/r \cdot \cos\theta$.

[0034] From this, it will be understood that the vehicle body velocity v must be increased in order to ensure that the vehicle body does not fall over without changing the will of the driver (that is, without changing the turning radius r) . According to the present invention, the two-wheeled vehicle can be prevented from overturning, for example, by deciding beforehand, in accordance with the vehicle body velocity v, the lean angle θ at which there is the concern that the vehicle body will overturn and increasing the vehicle body velocity v in a case where the actual lean angle θ exceeds that lean angle θ. In other words, the two-wheeled vehicle can be prevented from overturning by deciding beforehand, in accordance with the lean angle θ, the vehicle body velocity v at which there is the concern that the two-wheeled vehicle will overturn and controlling the drive force of the engine so that the velocity does not become equal to or lower than that velocity v.

[0035] In this specification, "lean angle" means a lateral lean angle and "lateral" means "laterally relative to the traveling direction" or "laterally relative to the major axis of the two-wheeled vehicle".

[0036] FIG. 2A is an example of a system configuration diagram including a two-wheeled vehicle overturn prevention device according to an embodiment of the

present invention. The two-wheeled vehicle overturn prevention device of the present invention is equipped with a vehicle velocity sensor 1 that detects a vehicle body velocity, a lean angle sensor 2 for detecting a lean angle of a vehicle body, lean angle calculating means 3 that calculates the lean angle of the vehicle body on the basis of an output value of the lean angle sensor 2, instability judging means 4 that judges traveling instability of the vehicle body on the basis of the vehicle body velocity and the lean angle, drive addition quantity calculating means 5 that calculates an engine drive addition quantity in a case where it has been judged by the instability judging means 4 that the vehicle body is unstable, and drive force increase instructing means 6 that outputs a drive addition quantity to an engine ECU (electronic control unit) . As shown in FIG. 2A, the lean angle calculating means 3, the instability judging means 4, the drive addition quantity calculating means 5, and the drive force increase instructing means 6 can be incorporated into an existing ABS-ECU. Furthermore, the two-wheeled vehicle overturn prevention device of the present invention may also be equipped with drive force increase limiting means not shown in the drawings. The drive force increase limiting means can change the drive addition quantity to zero to ensure that the vehicle body is not automatically accelerated in a case where the drive addition quantity that has been calculated by the drive addition quantity calculating means 5 has been maintained at a predetermined maximum value over a predetermined amount of time.

[0037] As the lean angle sensor 2, for example, a lateral acceleration sensor, a vertical acceleration sensor, a yaw rate sensor, and a roll rate sensor can be used. A lateral acceleration sensor can be used as the lean angle sensor 2 because it detects the gravitational acceleration of the sine component of the lean angle when the vehicle body has been leaned. Likewise, a vertical (height direction of the vehicle body) acceleration sensor can also be used. However, when only a lateral acceleration sensor or only a vertical acceleration sensor is used as the lean angle sensor, there are cases where, depending on the balance between the centrifugal force and gravity, the measured acceleration is extremely small and it is difficult to calculate the lean angle. For this reason, in the case of using an acceleration sensor as the lean angle sensor, it is necessary to use both a lateral acceleration sensor and a vertical acceleration sensor. In the case of using a yaw rate sensor, the lean angle θ can be calculated by time integrating the detected yaw rate. In addition, the lean angle θ can also be found using an optical sensor or an acoustic sensor. For example, two transmitters and two receivers can be attached to both sides of the vehicle body. In this case, the signals sent from the two transmitters are reflected by the road surface and received by the receivers, and the lean angle θ can be found on the basis of the difference in the time required by the signals. A method of using a yaw rate sensor to calculate the lean angle is described in JP-A-2004-155412, for example, and a method of using an optical sensor or an acoustic sensor to calculate the lean angle is described in JP-A-2004-83009, for example.

[0038] FIG. 2B shows an example of a system configuration diagram including a two-wheeled vehicle overturn prevention device according to another embodiment of the present invention. The two-wheeled vehicle overturn prevention device in the present embodiment is further equipped, in addition to the elements shown in FIG. 2A, with vehicle body velocity storing means 7 that stores an output value of the vehicle velocity sensor 1, vehicle body velocity estimating means 8 that calculates an estimated vehicle body velocity, which is a vehicle body velocity of the vehicle body after a predetermined amount of time, on the basis of a temporal change in the output value of the vehicle body sensor 1, lean angle storing means 9 that stores an output value of the lean angle calculating means 3, and lean angle estimating means 10 that calculates an estimated lean angle, which is a lean angle of the vehicle body after a predetermined amount of time, on the basis of a temporal change in the output value of the lean angle calculating means 3. These additional means can also be incorporated into an existing ABS-ECU. In this case, the instability judging means 4 judges instability of the vehicle body on the basis of the estimated vehicle body velocity that has been calculated by the vehicle body velocity estimating means 8 and the estimated lean angle that has been calculated by the lean angle estimating means 10. Furthermore, like the embodiment of FIG. 2A, in the present embodiment also, the two-wheeled overturn prevention device can be equipped with drive force increase limiting means not shown in the drawings. The drive force increase limiting means can change the drive addition quantity to zero to ensure that the vehicle body is not automatically accelerated in a case where the drive addition quantity that has been calculated by the drive addition quantity calculating means 5 has been maintained at a predetermined maximum value over a predetermined amount of time. According to the present embodiment, the traveling state of the vehicle body after a predetermined amount of time can be estimated and control can be performed, so the vehicle body can be accelerated at a more appropriate timing or the vehicle body can be kept from decelerating, and because of this, the two-wheeled vehicle can be more reliably prevented from overturning.

[0039] Next, processing implemented in accordance with the method of the present invention will be specifically described. FIG. 3A is a flowchart showing an example of vehicle body velocity control processing by the two-wheeled vehicle overturn prevention device of FIG. 2A based on the above-described principle.

[0040] First, the output value is acquired from the vehicle velocity sensor (vehicle wheel velocity sensor) 1 (step 1). Next, it is judged whether or not an actual vehicle body velocity (actual vehicle body velocity) V_a is equal to or lower than a predetermined value (step 2). The vehicle body is accelerated by the control processing according to the present invention, so in the present em-

bodiment, in consideration of safety, a predetermined maximum value (e.g., 50 km/hr) is preset in regard to the vehicle body velocity, and processing is executed only in a case where the actual vehicle body velocity is equal to or lower than the maximum value. Because of this, the two-wheeled vehicle can be prevented from being further accelerated during high-speed travel.

[0041] When it is judged that the vehicle body velocity V_a is equal to or lower than the predetermined value, the output value from the lean angle sensor 2 such as a yaw rate sensor, for example, is acquired (step 3). The actual lean angle (actual lean angle) θ of the vehicle body is calculated on the basis of this output value (step 4).

[0042] Next, in step 5, traveling instability of the vehicle body is judged, and for this judgment, maximum allowable lean angles θ_m (degrees) relative to vehicle body velocities V are mapped beforehand and stored in the ECU. The maximum allowable lean angles θ_m are maximum lean angles in a range in which there is no concern that the vehicle body traveling at a given vehicle body velocity V will overturn (or where it is supposed that the two-wheeled vehicle can be righted without overturning by the driver operating the accelerator) . In terms of the example of FIG. 4, the maximum allowable lean angle θ_m when the vehicle body velocity V = 30 km/hr is set to 40 degrees. The correlation between the vehicle body velocity V and the maximum allowable lean angle θ_m differs depending on the type of the vehicle body and is not limited to what is shown in FIG. 4, but regardless of the type of the vehicle body, the maximum allowable lean angle θ_m tends to become larger as the vehicle body velocity V increases.

[0043] When the lean angle θ that has been calculated is in the region on the lower side of the curve on the map (in other words, the stable region), it is easy for the two-wheeled vehicle to achieve a balance between its right and left sides, and consequently the two-wheeled vehicle can stably travel without concern on the part of the driver that the two-wheeled vehicle will overturn, so it is judged that the traveling state is stable (NO) . On the other hand, when the lean angle θ that has been calculated moves to the region on the upper side of the curve on the map (in other words, the unstable region), the two-wheeled vehicle is moving in the direction in which it will overturn, and it is judged that the traveling state is unstable (YES). In this case, it is necessary to increase the actual vehicle body velocity V_a, so in step 6, a drive addition quantity for output to the engine ECU is calculated. Additionally, a signal based on the drive addition quantity that has been calculated is output to the engine ECU. (step 7). On the basis of this signal, the engine ECU performs controls such as increasing the fuel injection quantity for acceleration and adjusting the opening degree of the throttle valve. These controls in the engine ECU are the same as what has been conventional, so description thereof will be omitted in this specification.

[0044] In a case where it has been judged in step 5 that the traveling state is stable (NO), the two-wheeled vehicle overturn prevention device returns to step 1 without performing the drive addition quantity calculation.

[0045] However, even when the two-wheeled vehicle overturn prevention device sends a drive addition command to the engine ECU, a time lag can occur until the actual engine drive force changes due to communication with the ECU and the engine ignition timing. Consequently, in the present invention, the two-wheeled vehicle overturn prevention device may also estimate the traveling state of the vehicle body after a predetermined amount of time and perform control so as change the engine drive force at a more appropriate timing.

[0046] FIG. 3B shows an example of vehicle body velocity control processing by the two-wheeled vehicle overturn prevention device shown in FIG. 2B. First, the output value is acquired from the vehicle velocity sensor (vehicle wheel velocity sensor) 1 (step 11). Next, it is judged whether or not the vehicle body velocity (actual vehicle body velocity) V_a is equal to or lower than the predetermined value (step 12) . When it is judged that the vehicle body velocity V_a is equal to or lower than the predetermined value (YES), in step 13, an estimated vehicle body velocity V_e, which is a vehicle body velocity after a preset predetermined amount of time (e.g., a predetermined amount of time from the current time in step 13), is calculated on the basis of a temporal change in the value of the actual vehicle body velocity V_a that has been stored in the vehicle body velocity storing means 7. Next, in step 14, an estimated lean angle θ_e, which is a lean angle after a preset predetermined amount of time (e.g., a predetermined amount of time from the current time in step 14), is calculated on the basis of a temporal change in the actual lean angle θ that has been stored in the lean angle storing means 9. However, the estimated lean angle θ_e may also be calculated in step 13 and the estimated vehicle body velocity V_e may also be calculated in step 14. In the present embodiment, the actual vehicle body velocity V_a that is the output value of the vehicle velocity sensor 1 and the actual lean angle θ that has been calculated on the basis of the output value of the lean angle sensor 2 are always stored in the vehicle body velocity storing means 7 and the lean angle storing means 9, respectively. In step 15, a judgment of the traveling instability of the vehicle body is performed on the basis of the estimated vehicle body velocity V_e and the estimated lean angle θ_e. The judging method is substantially the same as the one in the embodiment of FIG. 3A, and the judgment is performed on the basis of a map such as the one shown in FIG. 4, for example, which is stored beforehand in the ECU. That is, when the estimated lean angle θ_e is in the stable region on the lower side of the curve on the map, it is judged that the traveling state is stable (NO), and when the estimated lean angle θ_e is in the unstable region on the upper side of the curve on the map, it is judged that the traveling state is unstable (YES). In the case of YES, it is necessary to accelerate the vehicle body or keep the vehicle body from decelerating so that the traveling state after the predetermined

amount of time is in the stable region. Consequently, in step 16, a drive addition quantity for output to the engine ECU is calculated. Additionally, a signal based on the drive addition quantity that has been calculated is output to the engine ECU (step 17), and on the basis of this signal, the engine ECU performs controls such as increasing the fuel injection quantity and adjusting the opening degree of the throttle valve for acceleration or for keeping the vehicle from decelerating. Furthermore, in the present invention, even in a case where the estimated lean angle θ_e looks to move to the unstable region of FIG. 4, the two-wheeled vehicle overturn prevention device can judge in step 15 that the traveling state is unstable and perform control (that is, accelerating the vehicle body or keeping the vehicle body from decelerating) for not allowing the traveling state to move to the unstable region.

[0047] In this way, in the example of FIG. 3B, the judgment of the traveling instability of the vehicle body is performed on the basis of the estimated vehicle body velocity after the predetermined amount of time and the estimated lean angle after the predetermined amount of time. Because of this, the vehicle body can be accelerated at a more appropriate timing or the vehicle body can be kept from decelerating, so that the two-wheeled vehicle can be more reliably prevented from overturning.

[0048] In the present invention, the calculation of the drive addition quantity can be performed by PID control. This will be specifically described with reference again to FIG. 4.

[0049] In the case of the processing shown in FIG. 3A, let us suppose that, as shown in FIG. 4, there has been a change from a traveling state (X0) having an actual vehicle body velocity V1 and an actual lean angle $\theta 1$ to a traveling state (X1) having an actual vehicle body velocity V2 and an actual lean angle $\theta 2$. In this case, the traveling state after the change is in the unstable region, but it is possible to return the traveling state to a stable state without allowing the vehicle body to overturn by accelerating the vehicle body so as to minimize a difference ΔV between the actual vehicle body velocity V2 and a vehicle body velocity V3 corresponding to the actual lean angle $\theta 2$ serving as the maximum allowable lean angle. Consequently, PID based on the difference ΔV between the actual vehicle body velocity V2 and the target vehicle body velocity V3 is performed. The value calculated by this PID control is output to the engine ECU as a drive addition quantity.

[0050] Likewise, in the case of the processing shown in FIG. 3B, let us suppose that it has been estimated in the traveling state (X0) having the actual vehicle body velocity V1 and the actual lean angle $\theta 1$ that the traveling state after the predetermined amount of time is the traveling state (X1) having the estimated vehicle body velocity V2 and the estimated lean angle $\theta 2$. In this case, the traveling state can be prevented from moving to the unstable region and the two-wheeled vehicle can be prevented from overturning by accelerating the vehicle body or keeping the vehicle body from decelerating so as to minimize the difference ΔV between the estimated vehicle body velocity V2 and the vehicle body velocity V3 corresponding to the estimated lean angle $\theta 2$ serving as the maximum allowable lean angle. Consequently, PID based on the difference ΔV between the estimated vehicle body velocity V2 and the target vehicle body velocity V3 is performed, and the value calculated by this PID control is output to the engine ECU as a drive addition quantity.

[0051] However, as described above, the overturn prevention device of the present invention may also be equipped with drive force increase limiting means; in this case, a maximum value of the drive addition quantity that is output to the engine ECU is preset, and in a case where the drive addition quantity that has been calculated is maintained at the maximum value over the predetermined amount of time, the drive force increase limiting means may perform control that changes the drive addition quantity to zero after the drive addition quantity calculation (steps 6 and 16) and before the output to the engine ECU (steps 7 and 17). FIG. 5 shows an example of the action of the drive force increase limiting means. In this example, the maximum value of the drive addition quantity is set to 20 N·m, and the drive force increase limiting means changes the drive addition quantity to zero in a case where the drive addition quantity that is calculated in step 6 or step 16 is 20 N·m for 0.5 second. In this example, the drive addition quantity becomes zero after 1.0 second after reaching the maximum value. However, the specific maximum value of the drive addition quantity, the predetermined amount of time in which the maximum value is maintained, and the amount of time until the drive addition quantity is changed to zero are not limited to the example of FIG. 5. By limiting the drive force increase in this way, the two-wheeled vehicle can be prevented from being accelerated more than necessary in a case where an error has occurred in the lean angle detection value or the vehicle velocity correction quantity.

Industrial Applicability

[0052] The present invention can be widely applied to two-wheeled motor vehicles.

Reference Signs List

[0053]

1	Vehicle Velocity Sensor
2	Lean Angle Sensor
3	Lean Angle Calculating Means
4	Instability Judging Means
5	Drive Addition Quantity Calculating Means
6	Drive Force Increase Instructing Means
7	Vehicle Body Velocity Storing Means
8	Vehicle Body Velocity Estimating Means
9	Lean Angle Storing Means

10 Lean Angle Estimating Means
100 Vehicle Wheels
101 Upper Structure of Two-wheeled Vehicle
102 Head of Driver

Claims

1. A two-wheeled vehicle overturn prevention method, wherein

a) maximum allowable lean angles corresponding to vehicle body velocities are preset in relation to lean angles of a vehicle body,
b) an estimated lean angle, which is a lean angle of the vehicle body after a predetermined amount of time, is estimated on the basis of a temporal change in an actual lean angle of the vehicle body,
c) an estimated vehicle body velocity, which is a vehicle body velocity of the vehicle body after the predetermined amount of time, is estimated on the basis of a temporal change in an actual vehicle body velocity of the vehicle body, and
d) in a case where the estimated lean angle exceeds or looks to exceed a maximum allowable lean angle corresponding to the estimated vehicle body velocity, the two-wheeled vehicle overturn prevention method is adapted to accelerate the vehicle body or keep the vehicle body from decelerating.

2. The two-wheeled vehicle overturn prevention method according to claim 1, wherein in a case where the estimated lean angle exceeds a maximum allowable lean angle corresponding to the estimated vehicle body velocity, an engine drive addition quantity is calculated so as to minimize the difference between a vehicle body velocity corresponding to the estimated lean angle serving as a maximum allowable lean angle and the estimated vehicle body velocity.

3. A two-wheeled vehicle overturn prevention method, wherein

a) maximum allowable lean angles corresponding to vehicle body velocities are preset in relation to lean angles of a vehicle body, and
b) in a case where an actual lean angle of the vehicle body exceeds a maximum allowable lean angle corresponding to an actual vehicle body velocity of the vehicle body, the two-wheeled vehicle overturn prevention method is adapted to accelerate the vehicle body.

4. The two-wheeled vehicle overturn prevention method according to claim 3, wherein
in a case where an actual lean angle of the vehicle body exceeds a maximum allowable lean angle corresponding to an actual vehicle body velocity of the vehicle body, an engine drive addition quantity is calculated so as to minimize the difference between a vehicle body velocity corresponding to the actual lean angle serving as a maximum allowable lean angle and the actual vehicle body velocity.

5. The two-wheeled vehicle overturn prevention method according to claim 2 or 4, wherein the drive addition quantity is calculated by PID control.

6. The two-wheeled vehicle overturn prevention method according to claim 2, 4, or 5, wherein
a maximum value of the drive addition quantity is preset, and
in a case where the drive addition quantity that has been calculated has maintained the maximum value over a predetermined amount of time, the drive addition quantity is changed to zero.

7. The two-wheeled vehicle overturn prevention method according to any one of claims 1 to 6, wherein the method is executed only in a predetermined vehicle body velocity region.

8. The two-wheeled vehicle overturn prevention method according to any one of claims 1 to 7, wherein
an actual lean angle of the vehicle body is calculated on the basis of an output value of a lean angle sensor (2), and
the lean angle sensor (2) is at least one of a lateral acceleration sensor, a vertical acceleration sensor, a yaw rate sensor, and a roll rate sensor.

9. A two-wheeled vehicle overturn prevention device comprising:

i) a vehicle velocity sensor (1) that detects an actual vehicle body velocity of the vehicle body;
ii) a lean angle sensor (2) for detecting a lean angle of a vehicle body;
iii) lean angle calculating means (3) that calculates an actual lean angle of the vehicle body on the basis of an output value of the lean angle sensor;
iv) instability judging means (4) that judges traveling instability of the vehicle body on the basis of the vehicle body velocity and the lean angle;
v) drive quantity calculating means (5) that calculates an engine drive quantity in a case where it has been judged by the instability judging means that the vehicle body is unstable; and
vi) drive force instructing means (6) that outputs a drive quantity to an engine ECU;

a) wherein maximum allowable lean angles

corresponding to vehicle body velocities are preset in relation to lean angles of a vehicle body, and further comprising:

b) lean angle estimating means (10) that calculates an estimated lean angle, which is a lean angle of the vehicle body after a predetermined amount of time, on the basis of a temporal change in the actual lean angle output from the lean angle calculating means, and

c) vehicle body velocity estimating means (8) that calculates an estimated vehicle body velocity, which is a vehicle body velocity of the vehicle body after a predetermined amount of time, on the basis of a temporal change in the actual vehicle body velocity output from the vehicle velocity sensor, wherein

d) the instability judging means judges traveling instability of the vehicle body on the basis of the estimated vehicle body velocity, the estimated lean angle that has been calculated, and the maximum allowable lean angle and judges the traveling instability in a case where the estimated lean angle exceeds or looks to exceed a maximum allowable lean angle corresponding to the estimated vehicle body velocity, wherein

e) said drive quantity calculating means calculates an engine drive quantity and said drive force instructing means outputs a drive quantity to the engine ECU to accelerate the vehicle body or keep the vehicle body from decelerating, when said instability judging means judges said traveling instability of the vehicle body.

10. A two-wheeled vehicle overturn prevention device in which maximum allowable lean angles corresponding to vehicle body velocities are preset in relation to lean angles of a vehicle body and comprising:

i) a vehicle velocity sensor (1) that detects an actual vehicle body velocity of the vehicle body;
ii) a lean angle sensor (2) for detecting a lean angle of a vehicle body;
iii) lean angle calculating means (3) that calculates an actual lean angle of the vehicle body on the basis of an output value of the lean angle sensor;
iv) instability judging means (4) that judges traveling instability of the vehicle body on the basis of the maximum allowable lean angles and the actual lean angle, wherein the traveling instability is judged by the instability judging means in a case where the actual lean angle of the vehicle body exceeds a maximum allowable lean angle corresponding to the actual vehicle body velocity of the vehicle body;
v) drive quantity calculating means (5) that calculates an engine drive quantity in a case where it has been judged by the instability judging means that the vehicle body is unstable; and
vi) drive force instructing means (6) that outputs a drive quantity to an engine ECU;
vii) said drive quantity calculating means (5) calculates an engine drive quantity and said drive force instructing means outputs a drive quantity to the engine ECU to accelerate the vehicle body when said instability judging means judges said traveling instability.

11. The two-wheeled vehicle overturn prevention device according to claim 9 or 10, further comprising
vehicle body velocity storing means (7) that stores an output value of the vehicle velocity sensor (1), and
lean angle storing means (9) that stores an output value of the lean angle calculating means.

12. The two-wheeled vehicle overturn prevention device according to claim 9, wherein the drive quantity calculating means calculates an engine drive addition quantity so as to minimize the difference between a vehicle body velocity corresponding to the calculated lean angle serving as a maximum allowable lean angle and the vehicle body velocity that has been detected.

13. The two-wheeled vehicle overturn prevention device according to claim 9, wherein the drive quantity calculating means calculates an engine drive quantity so as to minimize the difference between a vehicle body velocity corresponding to the estimated lean angle serving as a maximum allowable lean angle and the estimated vehicle body velocity.

14. The two-wheeled vehicle overturn prevention device according to any one of claims 9 to 13, wherein the drive quantity calculating means calculates a drive addition quantity by PID control.

15. The two-wheeled vehicle overturn prevention device according to any one of claims 9 to 14, wherein
a maximum value of the drive quantity is preset, and
the two-wheeled vehicle overturn prevention device further comprises drive force increase limiting means which, in a case where the drive quantity that has been calculated has maintained the maximum value over a predetermined amount of time, changes the drive quantity to zero.

16. The two-wheeled vehicle overturn prevention device according to any one of claims 9 to 15, wherein the two-wheeled vehicle overturn prevention device acts only in a predetermined vehicle body velocity region.

17. The two-wheeled vehicle overturn prevention device according to any one of claims 9 to 16, wherein the lean angle sensor (2) is at least one of a lateral acceleration sensor, a vertical acceleration sensor, a yaw rate sensor, and a roll rate sensor.

Patentansprüche

1. Verfahren zur Umkippverhinderung bei einem Zweiradfahrzeug, wobei

a) Fahrzeugkarosseriegeschwindigkeiten zugehörige maximal zulässige Neigungswinkel in Bezug zu Neigungswinkeln einer Fahrzeugkarosserie voreingestellt sind,
b) ein geschätzter Neigungswinkel, der ein Neigungswinkel der Fahrzeugkarosserie nach einer festgelegten Zeitdauer ist, auf Grundlage einer zeitlichen Veränderung eines tatsächlichen Neigungswinkels der Fahrzeugkarosserie geschätzt wird,
c) eine geschätzte Fahrzeugkarosseriegeschwindigkeit, die eine Fahrzeugkarosseriegeschwindigkeit der Fahrzeugkarosserie nach einer festgelegten Zeitdauer ist, auf Grundlage einer zeitlichen Veränderung einer tatsächlichen Fahrzeugkarosseriegeschwindigkeit der Fahrzeugkarosserie geschätzt wird, und
d) in einem Fall, in dem der geschätzte Neigungswinkel einen der geschätzten Fahrzeugkarosseriegeschwindigkeit zugehörigen maximal zulässigen Neigungswinkel übersteigt oder es den Anschein hat, dass er ihn übersteigt, das Verfahren zur Umkippverhinderung bei einem Zweiradfahrzeug dazu eingerichtet ist, die Fahrzeugkarosserie zu beschleunigen oder die Fahrzeugkarosserie daran zu hindern, sich zu verlangsamen.

2. Verfahren zur Umkippverhinderung bei einem Zweiradfahrzeug nach Anspruch 1, wobei in einem Fall, in dem der geschätzte Neigungswinkel einen der geschätzten Fahrzeugkarosseriegeschwindigkeit zugehörigen maximal zulässigen Neigungswinkel übersteigt, eine Motorantriebszusatzmenge berechnet wird, um die Differenz zwischen einer dem geschätzten Neigungswinkel, der als maximal zulässiger Neigungswinkel dient, zugehörigen Fahrzeugkarosseriegeschwindigkeit und der geschätzten Fahrzeugkarosseriegeschwindigkeit zu minimieren.

3. Verfahren zur Umkippverhinderung bei einem Zweiradfahrzeug, wobei

a) Fahrzeugkarosseriegeschwindigkeiten zugehörige maximal zulässige Neigungswinkel in Bezug zu Neigungswinkeln einer Fahrzeugkarosserie voreingestellt sind, und
b) in einem Fall, in dem der tatsächliche Neigungswinkel der Fahrzeugkarosserie einen der tatsächlichen Fahrzeugkarosseriegeschwindigkeit der Fahrzeugkarosserie zugehörigen maximal zulässigen Neigungswinkel übersteigt, das Verfahren zur Umkippverhinderung bei einem Zweiradfahrzeug dazu eingerichtet ist, die Fahrzeugkarosserie zu beschleunigen.

4. Verfahren zur Umkippverhinderung bei einem Zweiradfahrzeug nach Anspruch 3, wobei
in einem Fall, in dem ein tatsächlicher Neigungswinkel der Fahrzeugkarosserie einen der tatsächlichen Fahrzeugkarosseriegeschwindigkeit zugehörigen maximal zulässigen Neigungswinkel übersteigt, eine Motorantriebszusatzmenge berechnet wird, um die Differenz zwischen einer dem tatsächlichen Neigungswinkel, der als maximal zulässiger Neigungswinkel dient, zugehörigen Fahrzeugkarosseriegeschwindigkeit und der tatsächlichen Fahrzeugkarosseriegeschwindigkeit zu minimieren.

5. Verfahren zur Umkippverhinderung bei einem Zweiradfahrzeug nach Anspruch 2 oder 4, wobei die Antriebszusatzmenge von einer PID-Steuerung berechnet wird.

6. Verfahren zur Umkippverhinderung bei einem Zweiradfahrzeug nach Anspruch 2, 4 oder 5, wobei ein Maximalwert der Antriebszusatzmenge voreingestellt ist und
in einem Fall, in dem die berechnete Antriebszusatzmenge den Maximalwert über eine festgelegte Zeitdauer gehalten hat, die Antriebszusatzmenge auf null geändert wird.

7. Verfahren zur Umkippverhinderung bei einem Zweiradfahrzeug nach einem der Ansprüche 1 bis 6, wobei das Verfahren nur in einem festgelegten Fahrzeugkarosseriegeschwindigkeitsbereich durchgeführt wird.

8. Verfahren zur Umkippverhinderung bei einem Zweiradfahrzeug nach einem der Ansprüche 1 bis 7, wobei ein tatsächlicher Neigungswinkel der Fahrzeugkarosserie auf Grundlage eines Ausgabewerts eines Neigungswinkelsensors (2) berechnet wird und
der Neigungswinkelsensor (2) ein Lateralbeschleunigungssensor, ein Vertikalbeschleunigungssensor, ein Gierratensensor und/oder ein Kippsensor ist.

9. Vorrichtung zur Umkippverhinderung bei einem Zweiradfahrzeug, Folgendes umfassend:

i) einen Fahrzeuggeschwindigkeitssensor (1), der eine tatsächliche Fahrzeugkarosseriegeschwindigkeit der Fahrzeugkarosserie erfasst;

ii) einen Neigungswinkelsensor (2) zum Erfassen eines Neigungswinkels einer Fahrzeugkarosserie;
iii) eine Neigungswinkelberechnungseinrichtung (3), die einen tatsächlichen Neigungswinkel der Fahrzeugkarosserie auf Grundlage eines Ausgabewerts des Neigungswinkelsensors berechnet;
iv) eine Instabilitätsbeurteilungseinrichtung (4), die die Fahrtinstabilität der Fahrzeugkarosserie auf Grundlage der Fahrzeugkarosseriegeschwindigkeit und des Neigungswinkels berechnet;
v) eine Antriebsmengenberechnungseinrichtung (5), die eine Motorantriebsmenge in einem Fall berechnet, in dem die Instabilitätsbeurteilungseinrichtung geurteilt hat, dass die Fahrzeugkarosserie instabil ist; und
vi) eine Antriebskraftanweisungseinrichtung (6), die einer Motor-ECU eine Antriebsmenge ausgibt;

a) wobei Fahrzeugkarosseriegeschwindigkeiten zugehörige maximal zulässige Neigungswinkel in Bezug zu Neigungswinkeln einer Fahrzeugkarosserie voreingestellt sind, und ferner Folgendes umfassend:
b) eine Neigungswinkelschätzeinrichtung (10), die einen geschätzten Neigungswinkel, der ein Neigungswinkel der Fahrzeugkarosserie nach einer festgelegten Zeitdauer ist, auf Grundlage einer zeitlichen Veränderung der tatsächlichen Ausgabe des Neigungswinkels von der Neigungswinkelberechnungseinrichtung berechnet, und
c) eine Fahrzeugkarosseriegeschwindigkeitsschätzeinrichtung (8), die eine geschätzte Fahrzeugkarosseriegeschwindigkeit, die eine Fahrzeugkarosseriegeschwindigkeit der Fahrzeugkarosserie nach einer festgelegten Zeitdauer ist, auf Grundlage einer zeitlichen Veränderung der tatsächlichen Ausgabe der Fahrzeugkarosseriegeschwindigkeit vom Fahrzeuggeschwindigkeitssensor berechnet, wobei
d) die Instabilitätsbeurteilungseinrichtung die Fahrtinstabilität der Fahrzeugkarosserie auf Grundlage der geschätzten Fahrzeugkarosseriegeschwindigkeit, des berechneten geschätzten Neigungswinkels und des maximal zulässigen Neigungswinkels beurteilt und die Fahrtinstabilität in einem Fall, in dem der geschätzte Neigungswinkel einen der geschätzten Fahrzeugkarosseriegeschwindigkeit zugehörigen maximal zulässigen Neigungswinkel übersteigt oder es den Anschein hat, dass er ihn übersteigt, beurteilt, wobei
e) die Antriebsmengenberechnungseinrichtung eine Motorantriebsmenge berechnet und die Antriebskraftanweisungseinrichtung an die Motor-ECU eine Antriebsmenge ausgibt, um die Fahrzeugkarosserie zu beschleunigen oder die Fahrzeugkarosserie daran zu hindern, sich zu verlangsamen, wenn die Instabilitätsbeurteilungseinrichtung die Fahrtinstabilität der Fahrzeugkarosserie beurteilt.

10. Vorrichtung zur Umkippverhinderung bei einem Zweiradfahrzeug, wobei den Fahrzeugkarosseriegeschwindigkeiten zugehörige maximal zulässige Neigungswinkel in Bezug zu Neigungswinkeln einer Fahrzeugkarosserie voreingestellt sind und Folgendes umfassen:

i) einen Fahrzeuggeschwindigkeitssensor (1), der eine tatsächliche Fahrzeugkarosseriegeschwindigkeit der Fahrzeugkarosserie erfasst;
ii) einen Neigungswinkelsensor (2) zum Erfassen eines Neigungswinkels einer Fahrzeugkarosserie;
iii) eine Neigungswinkelberechnungseinrichtung (3), die einen tatsächlichen Neigungswinkel der Fahrzeugkarosserie auf Grundlage eines Ausgabewerts des Neigungswinkelsensors berechnet;
iv) eine Instabilitätsbeurteilungseinrichtung (4), die die Fahrtinstabilität der Fahrzeugkarosserie auf Grundlage der maximal zulässigen Neigungswinkel und des tatsächlichen Neigungswinkels berechnet, wobei die Fahrtinstabilität von der Instabilitätsbeurteilungseinrichtung in einem Fall, in dem der tatsächliche Neigungswinkel der Fahrzeugkarosserie einen der tatsächlichen Fahrzeugkarosseriegeschwindigkeit der Fahrzeugkarosserie zugehörigen maximal zulässigen Neigungswinkel übersteigt, beurteilt wird;
v) eine Antriebsmengenberechnungseinrichtung (5), die eine Motorantriebsmenge in einem Fall berechnet, in dem die Instabilitätsbeurteilungseinrichtung geurteilt hat, dass die Fahrzeugkarosserie instabil ist; und
vi) eine Antriebskraftanweisungseinrichtung (6), die einer Motor-ECU eine Antriebsmenge ausgibt;
vii) wobei die Antriebsmengenberechnungseinrichtung (5) eine Motorantriebsmenge berechnet und die Antriebskraftanweisungseinrichtung eine Antriebsmenge an die Motor-ECU ausgibt, um die Fahrzeugkarosserie zu beschleunigen, wenn die Instabilitätsbeurteilungseinrichtung die Fahrtinstabilität beurteilt.

11. Vorrichtung zur Umkippverhinderung bei einem

Zweiradfahrzeug nach Anspruch 9 oder 10, ferner Folgendes umfassend:

eine Fahrzeugkarosseriespeichereinrichtung (7), die einen Ausgabewert des Fahrzeuggeschwindigkeitssensors (1) speichert, und
eine Neigungswinkelspeichereinrichtung (9), die einen Ausgabewert der Neigungswinkelberechnungseinrichtung speichert.

12. Vorrichtung zur Umkippverhinderung bei einem Zweiradfahrzeug nach Anspruch 9, wobei die Antriebsmengenberechnungseinrichtung eine Motorantriebszusatzmenge berechnet, um die Differenz zwischen einer zum berechneten Neigungswinkel, der als maximal zulässiger Neigungswinkel dient, zugehörigen Fahrzeugkarosseriegeschwindigkeit und der erfassten Fahrzeugkarosseriegeschwindigkeit zu minimieren.

13. Vorrichtung zur Umkippverhinderung bei einem Zweiradfahrzeug nach Anspruch 9, wobei die Antriebsmengenberechnungseinrichtung eine Motorantriebsmenge berechnet, um die Differenz zwischen einer zum geschätzten Neigungswinkel, der als maximal zulässiger Neigungswinkel dient, zugehörigen Fahrzeugkarosseriegeschwindigkeit und der geschätzten Fahrzeugkarosseriegeschwindigkeit zu minimieren.

14. Vorrichtung zur Umkippverhinderung bei einem Zweiradfahrzeug nach einem der Ansprüche 9 bis 13, wobei die Antriebsmengenberechnungseinrichtung eine Antriebszusatzmenge mittels einer PID-Steuerung berechnet.

15. Vorrichtung zur Umkippverhinderung bei einem Zweiradfahrzeug nach einem der Ansprüche 9 bis 14, wobei
ein Maximalwert der Antriebsmenge voreingestellt ist und
die Vorrichtung zur Umkippverhinderung bei einem Zweiradfahrzeug ferner eine Antriebskrafterhöhungseinschränkungseinrichtung umfasst, die in einem Fall, in dem die berechnete Antriebsmenge den Maximalwert über eine festgelegte Zeitdauer gehalten hat, die Antriebsmenge auf null ändert.

16. Vorrichtung zur Umkippverhinderung bei einem Zweiradfahrzeug nach einem der Ansprüche 9 bis 15,
wobei die Vorrichtung zur Umkippverhinderung bei einem Zweiradfahrzeug nur in einem festgelegten Fahrzeugkarosseriegeschwindigkeitsbereich wirkt.

17. Vorrichtung zur Umkippverhinderung bei einem Zweiradfahrzeug nach einem der Ansprüche 9 bis 16, wobei der Neigungswinkelsensor (2) ein Lateralbeschleunigungssensor, ein Vertikalbeschleunigungssensor, ein Gierratensensor und/oder ein Kippsensor ist.

Revendications

1. Procédé anti-renversement pour véhicules à deux roues, dans lequel

a) des angles d'inclinaison admissibles maximaux correspondant à des vitesses de carrosserie de véhicule sont prédéfinis par rapport à des angles d'inclinaison d'une carrosserie de véhicule,
b) un angle d'inclinaison estimé, qui est un angle d'inclinaison de la carrosserie de véhicule après un laps de temps prédéterminé, est estimé sur la base d'une variation temporelle d'un angle d'inclinaison réel de la carrosserie de véhicule,
c) une vitesse de carrosserie de véhicule estimée, qui est une vitesse de la carrosserie de véhicule après le laps de temps prédéterminé, est estimée sur la base d'une variation temporelle d'une vitesse réelle de la carrosserie de véhicule, et
d) dans le cas où l'angle d'inclinaison estimé dépasse ou est sur le point de dépasser un angle d'inclinaison admissible maximal correspondant à la vitesse de carrosserie de véhicule estimée, le procédé anti-renversement pour véhicules à deux roues est conçu pour accélérer la carrosserie de véhicule ou empêcher la carrosserie de véhicule de décélérer.

2. Procédé anti-renversement pour véhicules à deux roues selon la revendication 1, dans lequel, dans le cas où l'angle d'inclinaison estimé dépasse un angle d'inclinaison admissible maximal correspondant à la vitesse de carrosserie de véhicule estimée, une quantité d'addition d'entraînement de moteur est calculée de manière à réduire au minimum la différence entre une vitesse de carrosserie de véhicule correspondant à l'angle d'inclinaison estimé servant d'angle d'inclinaison admissible maximal et la vitesse de carrosserie de véhicule estimée.

3. Procédé anti-renversement pour véhicules à deux roues, dans lequel

a) des angles d'inclinaison admissibles maximaux correspondant à des vitesses de carrosserie de véhicule sont prédéfinis par rapport à des angles d'inclinaison d'une carrosserie de véhicule, et
b) dans le cas où un angle d'inclinaison réel de la carrosserie de véhicule dépasse un angle d'inclinaison admissible maximal correspon-

dant à une vitesse réelle de la carrosserie de véhicule, le procédé anti-renversement pour véhicules à deux roues est conçu pour accélérer la carrosserie de véhicule.

4. Procédé anti-renversement pour véhicules à deux roues selon la revendication 3, dans lequel,
dans le cas où un angle d'inclinaison réel de la carrosserie de véhicule dépasse un angle d'inclinaison admissible maximal correspondant à une vitesse réelle de la carrosserie de véhicule, une quantité d'addition d'entraînement de moteur est calculée de manière à réduire au minimum la différence entre une vitesse de carrosserie de véhicule correspondant à l'angle d'inclinaison réel servant d'angle d'inclinaison admissible maximal et la vitesse de carrosserie de véhicule réelle.

5. Procédé anti-renversement pour véhicules à deux roues selon la revendication 2 ou 4, dans lequel la quantité d'addition d'entraînement est calculée par commande PID.

6. Procédé anti-renversement pour véhicules à deux roues selon la revendication 2, 4 ou 5, dans lequel une valeur maximale de la quantité d'addition d'entraînement est prédéfinie, et
dans le cas où la quantité d'addition d'entraînement qui a été calculée a maintenu la valeur maximale pendant un laps de temps prédéterminé, la quantité d'addition d'entraînement est remplacée par zéro.

7. Procédé anti-renversement pour véhicules à deux roues selon n'importe laquelle des revendications 1 à 6, le procédé étant mis en œuvre seulement dans une plage prédéterminée de vitesses de carrosserie de véhicule.

8. Procédé anti-renversement pour véhicules à deux roues selon n'importe laquelle des revendications 1 à 7, dans lequel
un angle d'inclinaison réel de la carrosserie de véhicule est calculé sur la base d'une valeur de sortie d'un capteur d'angle d'inclinaison (2), et
le capteur d'angle d'inclinaison (2) est au moins l'un parmi un capteur d'accélération latérale, un capteur d'accélération verticale, un capteur de vitesse de lacet et un capteur de vitesse de roulis.

9. Dispositif anti-renversement pour véhicules à deux roues comprenant :

i) un capteur de vitesse de véhicule (1) qui détecte une vitesse réelle de la carrosserie de véhicule ;
ii) un capteur d'angle d'inclinaison (2) servant à détecter un angle d'inclinaison d'une carrosserie de véhicule ;
iii) un moyen de calcul d'angle d'inclinaison (3) qui calcule un angle d'inclinaison réel de la carrosserie de véhicule sur la base d'une valeur de sortie du capteur d'angle d'inclinaison ;
iv) un moyen d'évaluation d'instabilité (4) qui évalue l'instabilité de déplacement de la carrosserie de véhicule sur la base de la vitesse de carrosserie de véhicule et de l'angle d'inclinaison ;
v) un moyen de calcul de quantité d'entraînement (5) qui calcule une quantité d'entraînement de moteur dans le cas où il a été évalué par le moyen d'évaluation d'instabilité que la carrosserie de véhicule est instable ; et
vi) un moyen d'instruction de force d'entraînement (6) qui fournit une quantité d'entraînement à une unité de commande électronique de moteur ;

a) dans lequel des angles d'inclinaison admissibles maximaux correspondant à des vitesses de carrosserie de véhicule sont prédéfinis par rapport à des angles d'inclinaison d'une carrosserie de véhicule, et comprenant en outre
b) un moyen d'estimation d'angle d'inclinaison (10) qui calcule un angle d'inclinaison estimé, qui est un angle d'inclinaison de la carrosserie de véhicule après un laps de temps prédéterminé, sur la base d'une variation temporelle de la sortie d'angle d'inclinaison réel provenant du moyen de calcul d'angle d'inclinaison, et
c) un moyen d'estimation de vitesse de carrosserie de véhicule (8) qui calcule une vitesse de carrosserie de véhicule estimée, qui est une vitesse de la carrosserie de véhicule après un laps de temps prédéterminé, sur la base d'une variation temporelle de la sortie de vitesse de carrosserie de véhicule réelle provenant du capteur de vitesse de véhicule, dans lequel
d) le moyen d'évaluation d'instabilité évalue l'instabilité de déplacement de la carrosserie de véhicule sur la base de la vitesse de carrosserie de véhicule estimée, de l'angle d'inclinaison estimé qui a été calculé, et de l'angle d'inclinaison admissible maximal et évalue l'instabilité de déplacement dans le cas où l'angle d'inclinaison estimé dépasse ou est sur le point de dépasser un angle d'inclinaison admissible maximal correspondant à la vitesse de carrosserie de véhicule estimée, dans lequel
e) ledit moyen de calcul de quantité d'entraînement calcule une quantité d'entraînement de moteur et ledit moyen d'instruction de force d'entraînement fournit une quantité

d'entraînement à l'unité de commande électronique de moteur pour accélérer la carrosserie de véhicule ou empêcher la carrosserie de véhicule de décélérer, lorsque ledit moyen d'évaluation d'instabilité évalue ladite instabilité de déplacement de la carrosserie de véhicule.

10. Dispositif anti-renversement pour véhicules à deux roues dans lequel des angles d'inclinaison admissibles maximaux correspondant à des vitesses de carrosserie de véhicule sont prédéfinis par rapport à des angles d'inclinaison d'une carrosserie de véhicule et comprenant :

i) un capteur de vitesse de véhicule (1) qui détecte une vitesse réelle de la carrosserie de véhicule ;
ii) un capteur d'angle d'inclinaison (2) servant à détecter un angle d'inclinaison d'une carrosserie de véhicule ;
iii) un moyen de calcul d'angle d'inclinaison (3) qui calcule un angle d'inclinaison réel de la carrosserie de véhicule sur la base d'une valeur de sortie du capteur d'angle d'inclinaison ;
iv) un moyen d'évaluation d'instabilité (4) qui évalue l'instabilité de déplacement de la carrosserie de véhicule sur la base des angles d'inclinaison admissibles maximaux et de l'angle d'inclinaison réel, dans lequel l'instabilité de déplacement est évaluée par le moyen d'évaluation d'instabilité dans le cas où l'angle d'inclinaison réel de la carrosserie de véhicule dépasse un angle d'inclinaison admissible maximal correspondant à la vitesse réelle de la carrosserie de véhicule ;
v) un moyen de calcul de quantité d'entraînement (5) qui calcule une quantité d'entraînement de moteur dans le cas où il a été évalué par le moyen d'évaluation d'instabilité que la carrosserie de véhicule est instable ; et
vi) un moyen d'instruction de force d'entraînement (6) qui fournit une quantité d'entraînement à une unité de commande électronique de moteur ;
vii) ledit moyen de calcul de quantité d'entraînement (5) calcule une quantité d'entraînement de moteur et ledit moyen d'instruction de force d'entraînement fournit une quantité d'entraînement à l'unité de commande électronique de moteur pour accélérer la carrosserie de véhicule lorsque ledit moyen d'évaluation d'instabilité évalue ladite instabilité de déplacement.

11. Dispositif anti-renversement pour véhicules à deux roues selon la revendication 9 ou 10, comprenant en outre
un moyen de mémorisation de vitesse de carrosserie de véhicule (7) qui mémorise une valeur de sortie du capteur de vitesse de véhicule (1), et
un moyen de mémorisation d'angle d'inclinaison (9) qui mémorise une valeur de sortie du moyen de calcul d'angle d'inclinaison.

12. Dispositif anti-renversement pour véhicules à deux roues selon la revendication 9, dans lequel le moyen de calcul de quantité d'entraînement calcule une quantité d'addition d'entraînement de moteur de manière à réduire au minimum la différence entre une vitesse de carrosserie de véhicule correspondant à l'angle d'inclinaison calculé servant d'angle d'inclinaison admissible maximal et la vitesse de carrosserie de véhicule qui a été détectée.

13. Dispositif anti-renversement pour véhicules à deux roues selon la revendication 9, dans lequel le moyen de calcul de quantité d'entraînement calcule une quantité d'addition d'entraînement de moteur de manière à réduire au minimum la différence entre une vitesse de carrosserie de véhicule correspondant à l'angle d'inclinaison estimé servant d'angle d'inclinaison admissible maximal et la vitesse de carrosserie de véhicule estimée.

14. Dispositif anti-renversement pour véhicules à deux roues selon n'importe laquelle des revendications 9 à 13, dans lequel le moyen de calcul de quantité d'entraînement calcule une quantité d'addition d'entraînement par commande PID.

15. Dispositif anti-renversement pour véhicules à deux roues selon n'importe laquelle des revendications 9 à 14, dans lequel
une valeur maximale de la quantité d'entraînement est prédéfinie, et
le dispositif anti-renversement pour véhicules à deux roues comprend en outre un moyen de limitation d'augmentation de force d'entraînement qui, dans le cas où la quantité d'entraînement qui a été calculée a maintenu la valeur maximale pendant un laps de temps prédéterminé, remplace la quantité d'entraînement par zéro.

16. Dispositif anti-renversement pour véhicules à deux roues selon n'importe laquelle des revendications 9 à 15, dans lequel le dispositif anti-renversement pour véhicules à deux roues agit seulement dans une plage prédéterminée de vitesses de carrosserie de véhicule.

17. Dispositif anti-renversement pour véhicules à deux roues selon n'importe laquelle des revendications 9 à 16, dans lequel le capteur d'angle d'inclinaison (2) est au moins l'un parmi un capteur d'accélération latérale, un capteur d'accélération verticale, un capteur de vitesse de lacet et un capteur de vitesse de roulis.

FIG. 1

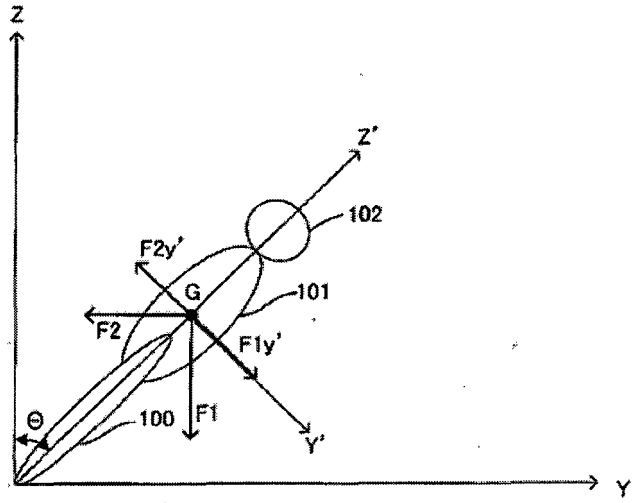
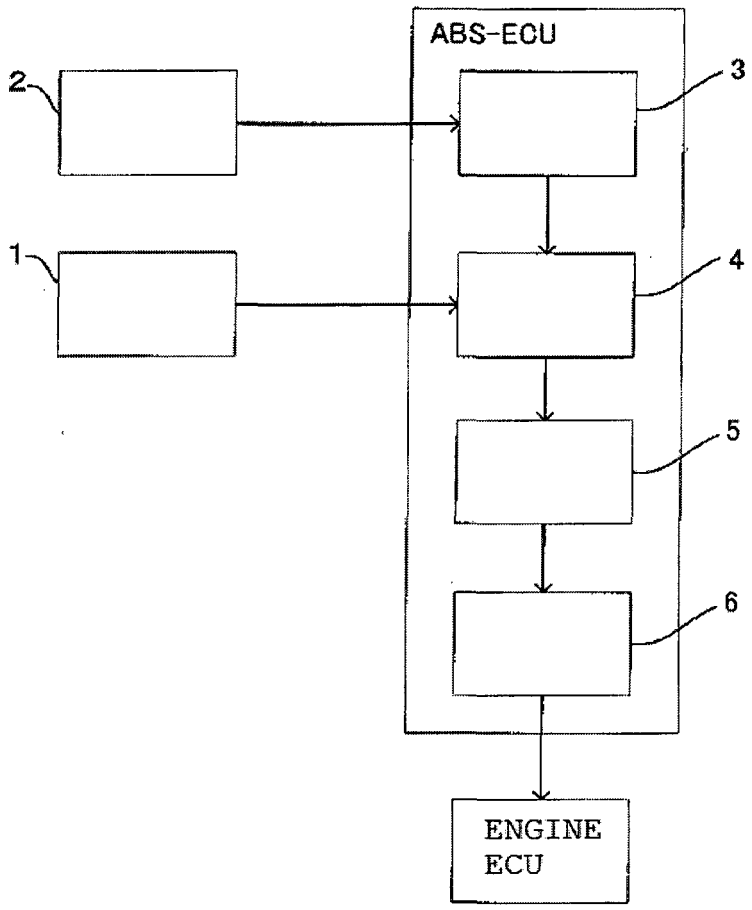
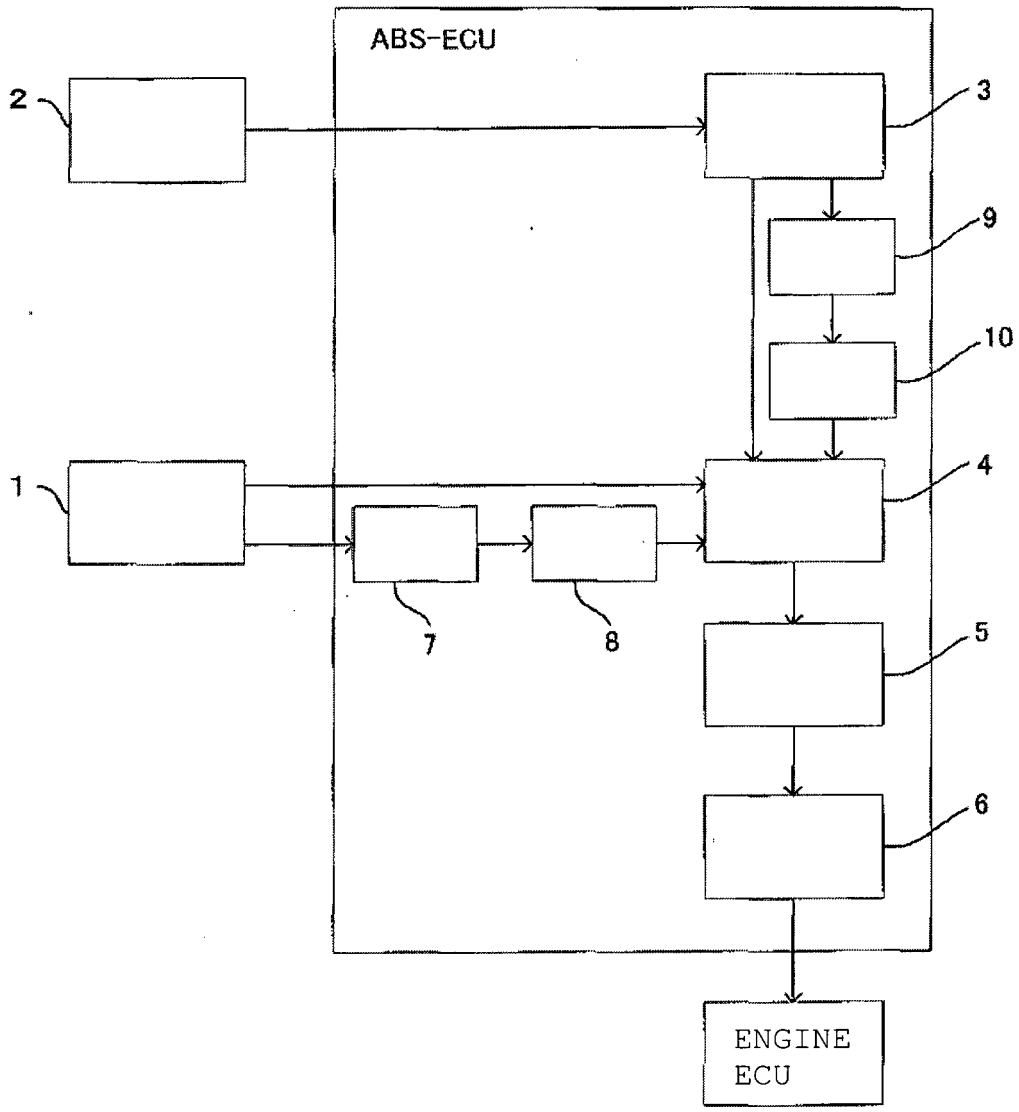


FIG. 2A



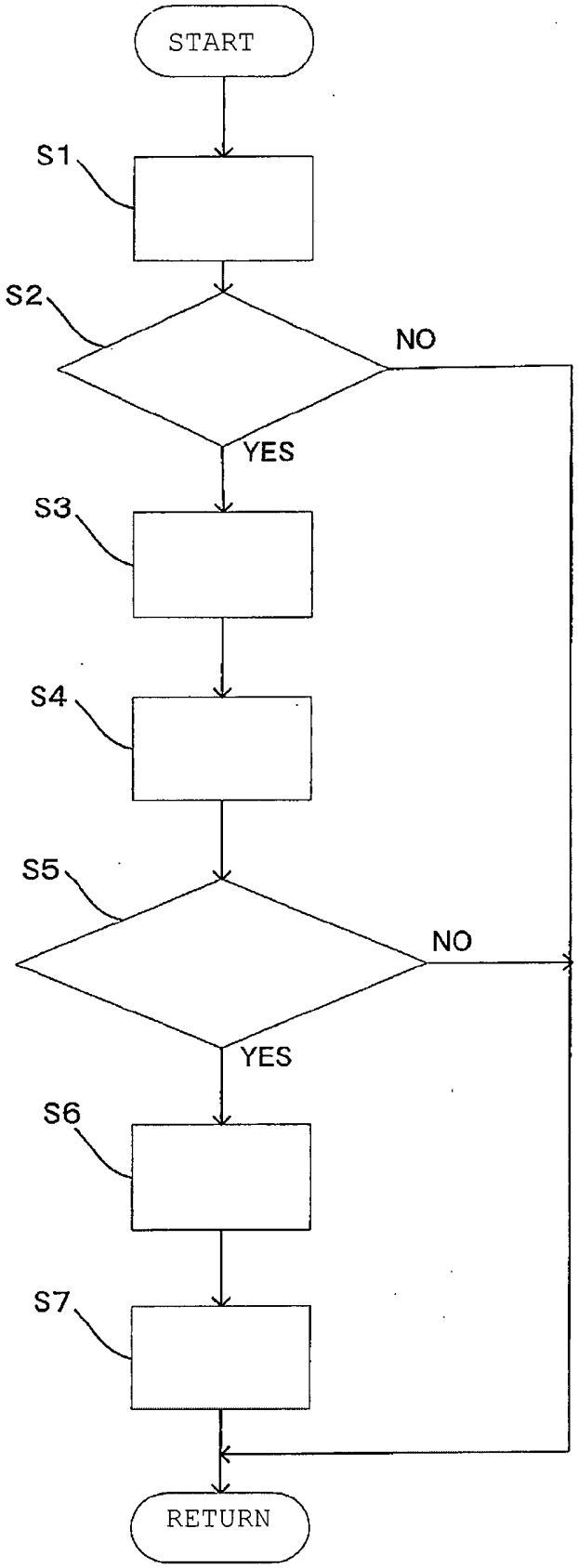
1 VEHICLE VELOCITY SENSOR
2 LEAN ANGLE SENSOR
3 LEAN ANGLE CALCULATING MEANS
4 INSTABILITY JUDGING MEANS
5 DRIVE ADDITION QUANTITY CALCULATING MEANS
6 DRIVE FORCE INCREASE INSTRUCTING MEANS

FIG. 2B



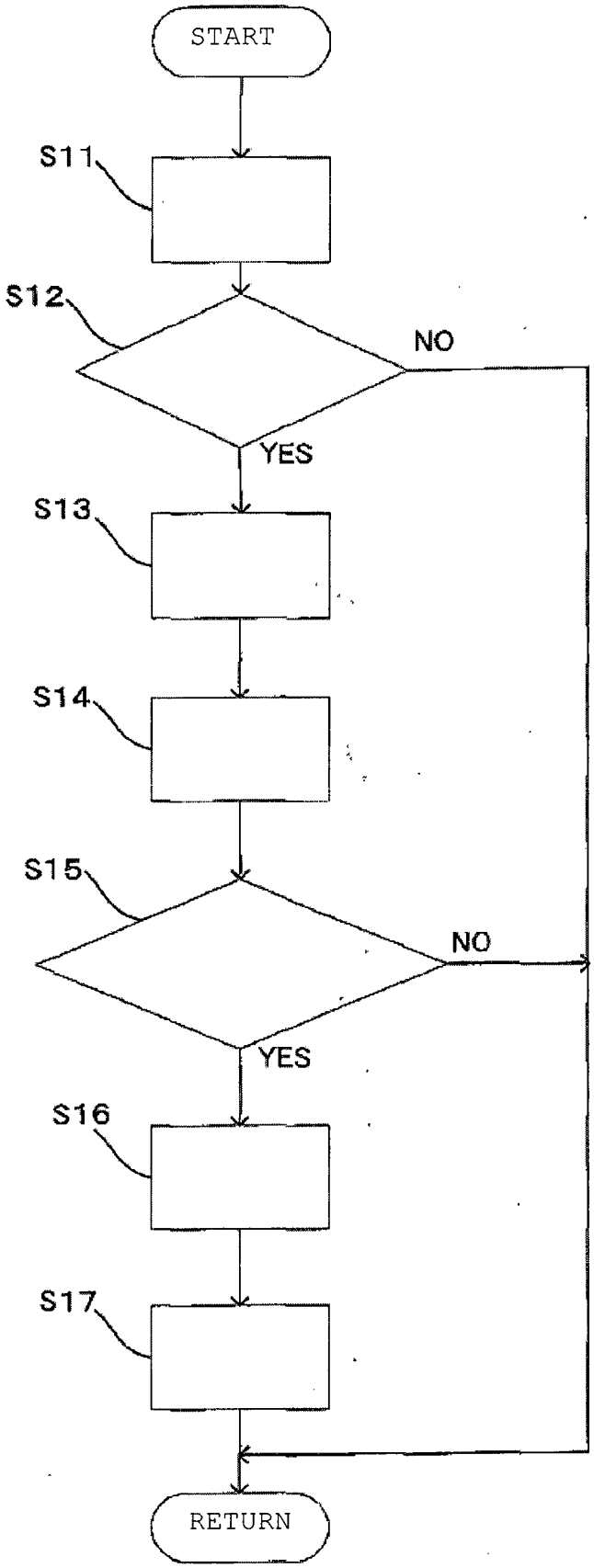
1 VEHICLE VELOCITY SENSOR
2 LEAN ANGLE SENSOR
3 LEAN ANGLE CALCULATING MEANS
4 INSTABILITY JUDGING MEANS
5 DRIVE ADDITION QUANTITY CALCULATING MEANS
6 DRIVE FORCE INCREASE INSTRUCTING MEANS
7 VEHICLE BODY VELOCITY STORING MEANS
8 VEHICLE BODY VELOCITY ESTIMATING MEANS
9 LEAN ANGLE STORING MEANS
10 LEAN ANGLE ESTIMATING MEANS

FIG. 3A



S1 ACQUIRE OUTPUT VALUE OF VEHICLE VELOCITY SENSOR
S2 IS ACTUAL VEHICLE BODY VELOCITY Va EQUAL TO OR LOWER THAN PREDETERMINED VALUE?
S3 ACQUIRE OUTPUT VALUE OF LEAN ANGLE SENSOR
S4 CALCULATE ACTUAL LEAN ANGLE θ
S5 IS TRAVELING STATE UNSTABLE?
S6 CALCULATE DRIVE ADDITION QUANTITY
S7 OUTPUT DRIVE ADDITION QUANTITY TO ENGINE ECU

FIG. 3B



S11 ACQUIRE OUTPUT VALUE OF VEHICLE VELOCITY SENSOR
S12 IS ACTUAL VEHICLE BODY VELOCITY Va EQUAL TO OR LOWER THAN PREDETERMINED VALUE?
S13 CALCULATE ESTIMATED VEHICLE BODY VELOCITY Ve
S14 CALCULATE ESTIMATED LEAN ANGLE θe
S15 IS TRAVELING STATE UNSTABLE?
S16 CALCULATE DRIVE ADDITION QUANTITY
S17 OUTPUT DRIVE ADDITION QUANTITY TO ENGINE ECU

FIG. 4

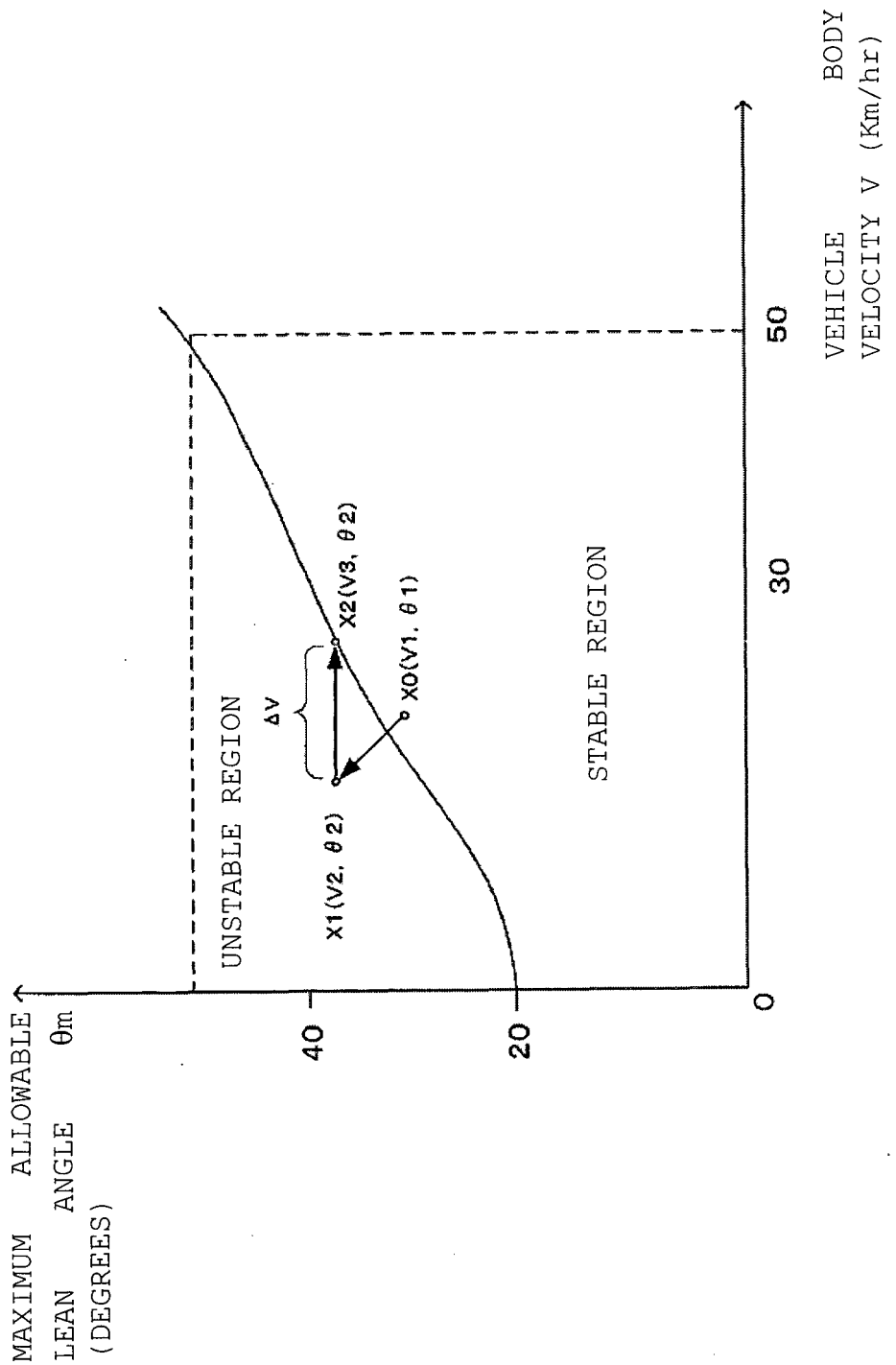
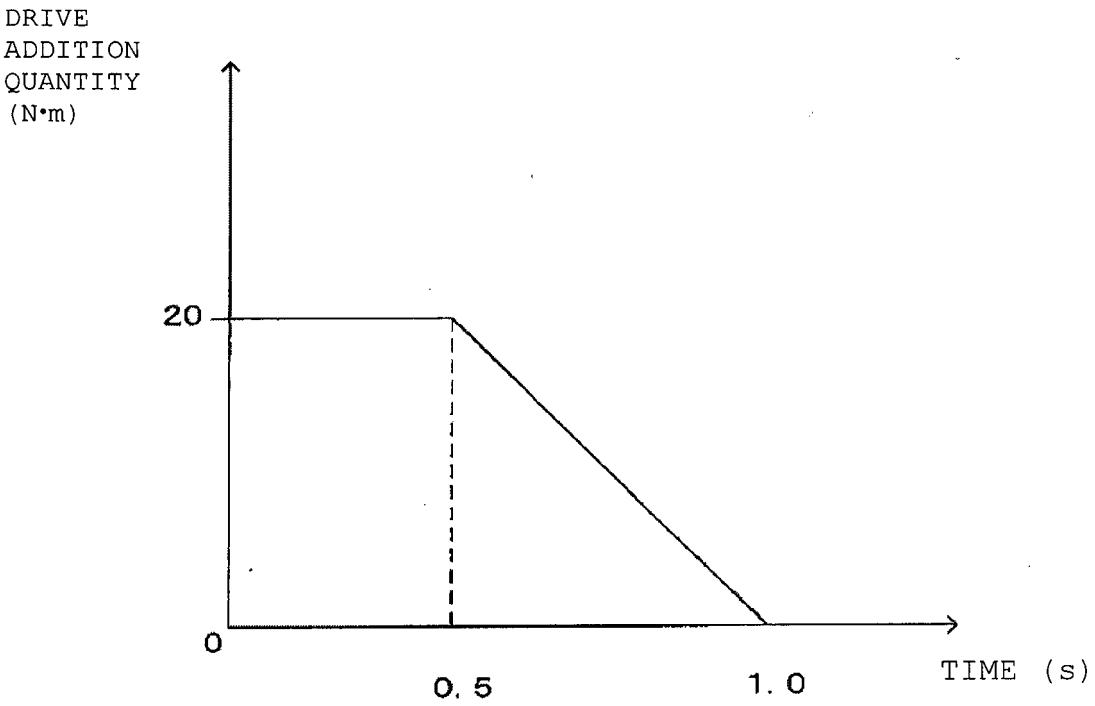

MAXIMUM ALLOWABLE LEAN ANGLE θm (DEGREES)
VEHICLE BODY VELOCITY V (Km/hr)
UNSTABLE REGION
STABLE REGION
ΔV
X1(V2, θ2)
X2(V3, θ2)
X0(V1, θ1)
40
20
0
30
50

FIG. 5



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2004099026 A **[0002] [0003]**
- DE 3839520 A **[0003]**
- JP 2004155412 A **[0037]**
- JP 2004083009 A **[0037]**